PROSTAR SOFTSTARTER

PRR1000 SERIES

15～315KW

INSTRUCTION MANUAL

PREFACE

Thank you for your choice of Prostar Soft Starter.
As the return of your trust we will provide the perfect quality and wholehearted service to you.

Adopting modern control theory, modularization design, DSP controlled high quality material and parts/components, together with advanced SMT manufacturing engineering, PRR1000 series softstarter is a high tech product combing digit, computer and modern automatic control theories. It is characteristic of high performance, high quality and skinny volume, and is widely applicable for starting and protection of three-phase motors in various industries.

Notes

This instruction manual provides information with respects to installation, parameter-setting, trouble-diagnosing and proper operation. This manual should therefore be kept properly and a careful reading shall be required before any operation attempt to avoid any accidental casualties or damage(s) to the facilities.

★ Special Notice:

▲ Installation, operation, maintenance or checking to this product shall be required before reading carefully this instruction manual and ensuring proper use.

▲ Power shall be disconnected before any wiring. Never touch power terminal with hand or conduct object.

Never put or drop foreign substance into soft starter.

▲ Connect input terminals R, S and T to urban power supply of 380V; connect output terminals U, V and W to motor.

▲ Grounding terminal PE shall be properly earth connected (grounding impedance not exceeding 4Ω).

▲ Capacitance can not be connected to the output of softstarter, but capacitance can be connected to the input of softstater when it is used for improving power factor.

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1. Product Model and Consignee Check

Please check the product carefully according to the following steps after unpacking, please contact the supplier immediately if any problem is found.

☞ PRR1015————PRR1055

☞ PRR1075————PRR1200

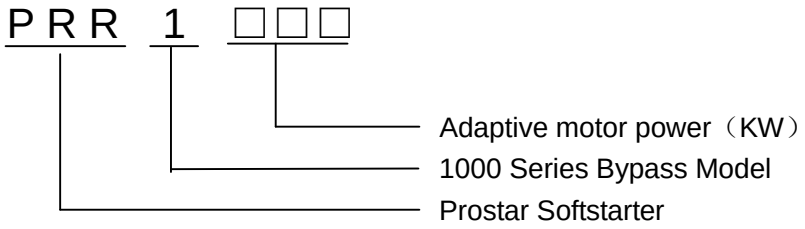
☞ PRR1220————PRR1315

Standards for Product Design

- GB/T 12668.2 2002 Standard of .rated value for low voltage AC frequency conversion electric drive system.
- GB/T 12668.3 2003 Standard and testing method of electromagnetism compatibility.

1.1 Nameplate Check

Model Illustration:



1.2 Product Check-up

Product check- up is advised to be carried out to make sure whether damage(s) revived during transportation, such as depressed shell, distortion, loose connection with wiring or connected parts.

1.3 Unpacking Check-up

Each softstarter has certificate of quality and user's manual. Please make sure whether the certificate and the manual are intact and conform to each other.

2. Installation

For keeping a good product capability, the softstarter must be installed vertically. Installation space should strictly obey the following requirements. Good ventilation should be available to the installation environment, which should avoid direct sunlight for indoor installation.

Environment temperature: －10℃～＋50℃

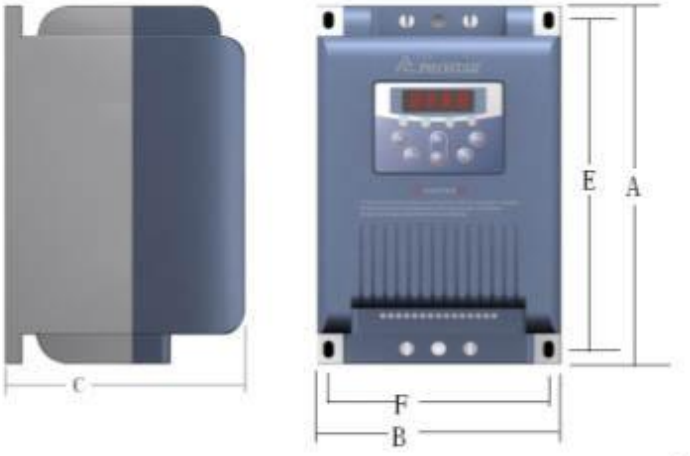
Relative humidity: ≤95% (20℃±5℃)

Environment conditions: Free from flammable gas, explosive gas and corrosive gas, free from electric dust, to be installed indoors with good ventilation.

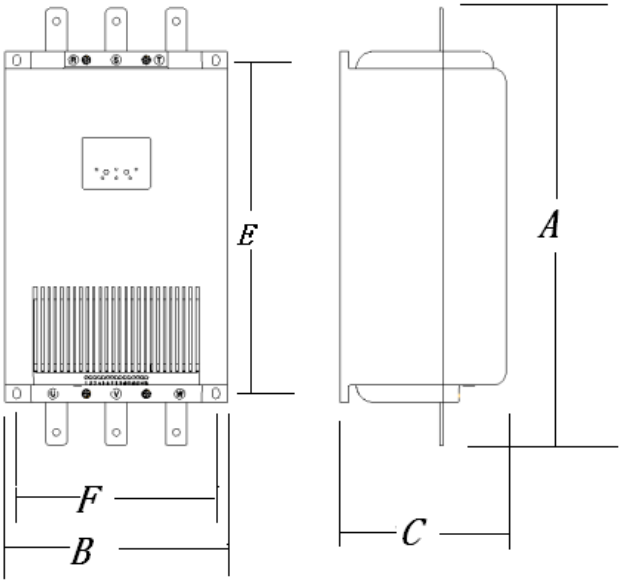
Vibration below 0.5G

If the altitude is above 2000m, the capacity should be decreased accordingly for application.

Structure Dimension: 15KW-55KW



Structure Dimension: 75KW-315KW



External Dimension（Unit:mm）

Model	A（High）	B(Wide)	C（Thick）
PRR1015（15KW）	250	153	162
PRR1022（22KW）	250	153	162
PRR1030（30KW）	250	153	162
PRR1037（37KW）	250	153	162
PRR1045（45KW）	250	153	162
PRR1055（55KW）	250	153	162
PRR1075（75KW）	510	260	194
PRR1090（90KW）	510	260	194
PRR1110（110KW）	510	260	194
PRR1132（132KW）	510	260	194
PRR1160（160KW）	510	260	194
PRR1200（200KW）	510	260	194
PRR1220（220KW）	590	360	255
PRR1250（250KW）	590	360	255
PRR1280（280KW）	590	360	255
PRR1315（315KW）	590	360	255

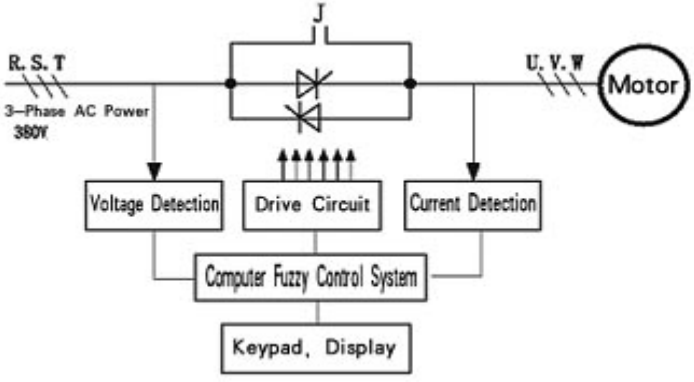
Installation Dimension（Unit: mm）

Model	E（High）	F(Wide)	Φ(Hole Dia）
PRR1015	219	140	Φ6
PRR1022	219	140	Φ6
PRR1030	219	140	Φ6
PRR1037	219	140	Φ6
PRR1045	219	140	Φ6
PRR1055	219	140	Φ6
PRR1075	389	232.5	Φ8.5
PRR1090	389	232.5	Φ8.5

PRR1110	389	232.5	Φ8.5
PRR1132	389	232.5	Φ8.5
PRR1160	389	232.5	Φ8.5
PRR1200	389	232.5	Φ8.5
PRR1220	560	300	Φ8.5
PRR1250	560	300	Φ8.5
PRR1280	560	300	Φ8.5
PRR1315	560	300	Φ8.5

Note: PRR1015--PRR1200 softstarter with plastic housing, available in stock.
PRR1220--PRR1315 softstarter with metal housing, available in stock.

3. Functional Block Diagram



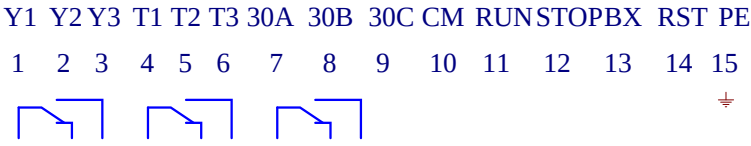
Three reverse-parallel connection SCR modules are adopted as power element. The softstarter can pick up synchronization signal from input voltage sampling, and realize feedback fuzzy control by output current sampling, trace the phase automatically and control phase displacement angle. Voltage can thus be increased step by step, and startup current will be under control. After startup, the bypass contactor will short-circuit the SCR. The motor will finally be driven into the electricity network for operation.

4. Technical Parameters

Control power supply	AC 380V±20%, 50/60Hz
3-Phase power supply	AC 380V±20%, 50/60Hz
Nominal current	30A～630A, totally 16 kinds of rated currents
Motor power	15～315KW(rated voltage 380V)
Applicable motor	Common squirrel cage type asynchronism motor
Startup mode	Voltage kick soft startup; current limiting startup (150~400%, adjustable); voltage ramp startup (1～180seconds, adjustable)
Stop mode	Free stop; soft stop (1～180seconds , adjustable)
Relay output	Delay running output; fault output; full voltage output (by pass) [contact dot: 5A, 250VAC]
Startup frequency	for frequent or infrequent startup; Advise: not exceeding ten times per hour
Protection function	Phase loss of input, over-load, short circuit, over-heating, and etc.
Safety degree	IP20
Cooling mode	Cooling naturally
Installation mode	Hanging mode
Environment conditions	Environment temperature:-10℃~＋50℃ Relative humidity:≤95%(20℃±5℃) Free from flammable gas, explosive gas and corrosive gas, free from electric dust, to be installed indoors with good ventilation Vibration below 0.5G If the altitude is above 2000m, the capacity should be decreased accordingly for application.

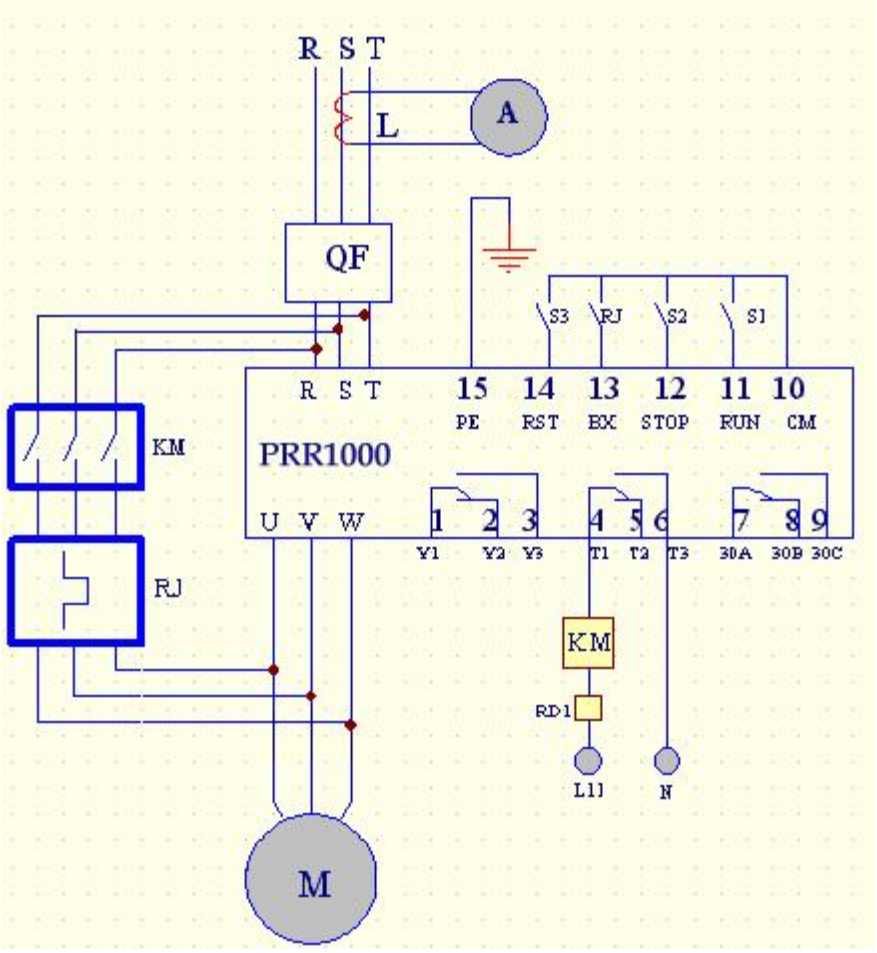
5．Wiring

5.1 Terminal Function



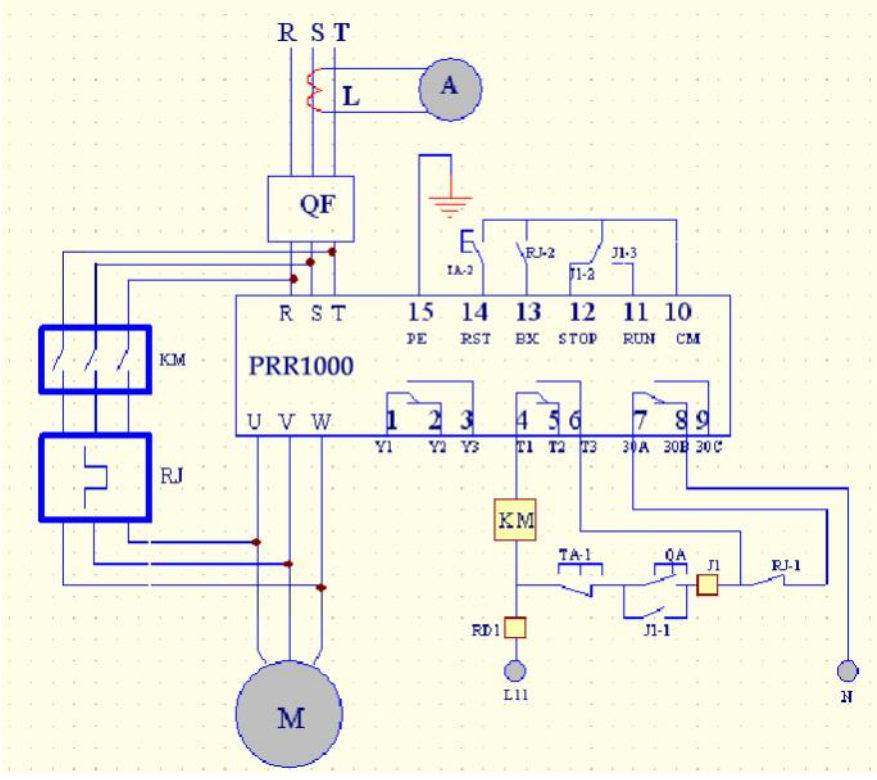
Terminal Number	Terminal Name	Description	Technical Parameters
1	Start-delay Signal	Y1: Middle terminal	AC250V5A
2	Start-delay Signal	Y2-Y1Normal close	AC250V5A
3	Start-delay Signal	Y3-Y1Normal open	AC250V5A
4	Bypass Signal	T1: Middle terminal	AC250V5A
5	Bypass Signal	T2-T1Normal close	AC250V5A
6	Bypass Signal	T3-T1Normal open	AC250V5A
7	Fault Signal	30A: Middle terminal	AC250V5A
8	Fault Signal	30B-30A Normal close	AC250V5A
9	Fault Signal	30C-30A Normal open	AC250V5A
10	Common Terminal	CM(External Common Terminal)	
11	Startup Signal	RUN-CM effective turn on	
12	Stop Signal	STOP-CM effective turn on	
13	Free stop Signal	BX-CM effective turn on	
14	Reset Signal	RST-CM effective turn on	
15	Function Ground -Terminal	PE—Ground	

5.2 Basic Wiring Diagram



R, S, T terminals of softstarter are input terminals while U, V, W are output terminals. QF-auto air breaker, KM-contactor, RJ-over heating protection relay, RD1-fuse, L11—N is connected to 220V.

5.3 Recommended Wiring Diagram



!PE Grounding wire should be as short as possible, and should be connected to the nearest grounding point, better on the installation board against the softstarter. Installation board should also be grounded.

Controlling Loop:

User can select to use bypass contactor. It can be switched to bypass circuit running automatically. To select this operation mode, an AC contactor should be fixed (to be ordered separately)

5.4 Optional Parts

Adaptable Motor(KW)	Model	Rated Current（A）	Contactor Model （optional）	Wiring （MM^2）
15	PRR1015	30	CJX4-50	10
22	PRR1022	45	CJX4-50	10
30	PRR1030	60	CJX4-80	16
37	PRR1037	76	CJX4-80	16
45	PRR1045	90	CJX4-95	25
55	PRR1055	110	CJX4-115F	25
75	PRR1075	150	CJX4-150F	35
90	PRR1090	180	CJX4-185F	35
110	PRR1110	218	CJX4-225F	50
132	PRR1132	260	CJX4-265F	60
160	PRR1160	320	CJX4-330F	75
200	PRR1200	400	CJX4-500F	90
220	PRR1220	440	CJX4-500F	90
250	PRR1250	500	CJX4-630F	150
280	PRR1280	560	CJX4-630F	150
315	PRR1315	630	CJX4-630F	150

6. Setting

Keypad Panel

Keys	Name of Keys	Note The following is the operation instruction of keypad panel. Fig 1-1 keypad panel
Mode	"mode" key	Control box displays function code "PR××". The current and "stop" key switch to each other.
set	"set" key	To be used with "mode" key. Under the "PR××" display state, press "set" key, the control box will display the corresponding value of function code. Press "up" and "down" key to change its value, and then press "set" to save the changed value.
▲	"up" key	Under "PR××" display state, press "up", "down" key to select other function code. After enter the function code, they are used to change the value of the function code.
▼	"down" key	
run	"run" key	Press"run" key for startup.
Stop/Reset	"stop/reset" key	Under any state, press "stop/reset" key, it will have priority to be valid. Press twice for free stop of the softstarter. And it also can reset the softstarter when malfunction happens.

Special Display Content and Interpretation

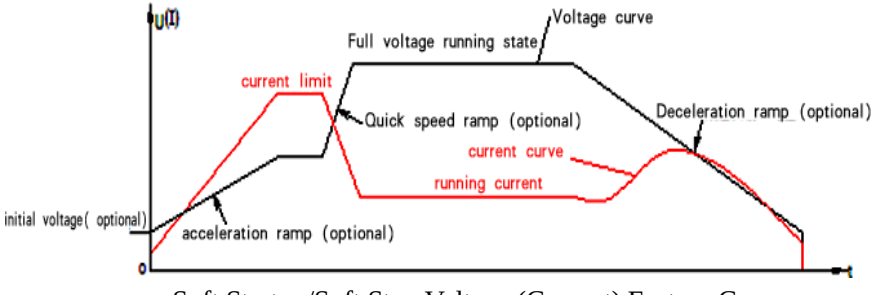
Display Items	Interpretation
—PR—	Show reset process; under single control mode, it displays such content after reset normally;
RUN	startup state
STOP	Stop state
OUT	Run state
SST	Soft-stop state
Count Down	Delay state

Set the Starter through Keypad

Main adjustable parameters： Initial voltage
Startup time
Stop time
Startup current

Startup mode： Voltage ramp soft startup
Current limiting soft startup
Kick soft startup

Stop mode: voltage ramp soft stop mode
Free stop mode



Soft Startup/Soft Stop Voltage (Current) Feature Curve

6.1 Initial Voltage Setting (U0)

Initial voltage for startup (0--50%)Ue, stepless adjustable.
Initial voltage for kick startup, voltage (20%-100%) Ue, stepless adjustable。
Select 100% as full voltage startup, at present the softstarter works as a switch without contact.

6.2 Startup Ramp Time Setting

Ramp ascending time: 1-180S, adjustable。

6.3 Stop Ramp Time Setting

Ramp descending time:1-180S, adjustable。

6.4 Startup Current Limit

Startup current (1.5～4) Ie : stepless adjustable. (with the data set, the biggest startup current will be limited in this range)

☞ The above parameters should be set when the starter is not working! Under the startup, soft-stop and full-voltage working state, all the parameter-settings will not be effective.

All the technical parameters of softstarter are effective when the environment temperature is below 45℃. If the environment temperature is from 45℃ to 60℃, the rated power should be decreased by a power-level.

7. Softstarter Function Chart

Function No.	Function Explanation	Data Explanation	Mfr Value
PR00	Control mode	0 keypad control 1 External terminal control	1
PR01	Startup mode	0 Voltage ramp startup 1 Current limit startup 2 Kick startup	1
PR02	Startup delay time	0-600S	0S
PR03	Stop mode	0 Free stop 1 Soft stop	0
PR04	Torque compensation	0-50% Rated voltage	5%
PR05	Kick voltage	20-100%Rated voltage	50%
PR06	Kick time	1-60S	2S
PR07	Ramp ascending time	1-180S	20S
PR08	Ramp descending time	1-180S	20S
PR09	Startup current limit	150-400% Rated current	400%
PR10	Startup time interval	1-3600S	240S
PR11	Data initialization	0 No action 1Action (manufacturer value restored)	0
PR12	Fault memory 1	Present fault	
PR13	Fault memory 2	previous fault	
PR14	Fault memory 3	Previous two faults	
PR15	Fault memory elimination	0 No Action 1 action	0
PR16	Overload protection time	1-180S	60S
PR17	OL protect value	100-400% rated current	300
PR18	Stop bits	0 one 1 two	0
PR19	Parity check	0 Odd 1 Even 2 No check	0
PR20	Communication baud rate	0: 1200 bit 1: 2400 bit 2: 4800 bit 3: 9600 bit 4: 19200 bit	2
PR21	Communication Address	1-127: softstarter address	1

PR22	Selection of ASCII mode and RTU mode	0 ASCII mode 1 RTU mode	0
PR23	Motor power	1-315KW	22KW
PR24	Reserved	0~9999	0

8. Function in Details

PR00	Control mode	0 Keypad control 1 external terminal control	1

Control mode selection can be operated directly through the panel keypad, and can also be done by external terminal control. The manufacturer value is 1.

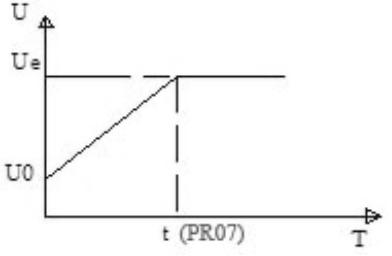
PR01	Startup mode	0 Voltage ramp startup 1 Current limit startup 2 Kick startup	1

You can start by selecting one of the following three modes：

0 Voltage ramp startup, 1 current limit startup, 2 kick startup, manufacturer value is 1

△Voltage ramp startup

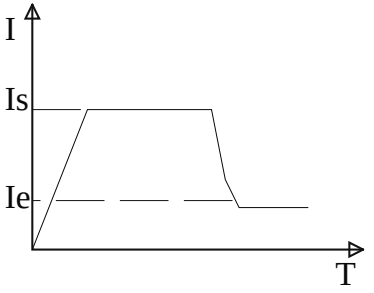
Set PR01 to 0, and set ramp startup time t (PR07) and torque compensation voltage (PR04) U0, the motor will start along with the increasing input voltage, and the speed will accelerate accordingly till its top speed, as shown in Figure (1).



Voltage Ramp Startup Feature Curve, Figure (1)

△Current limit startup

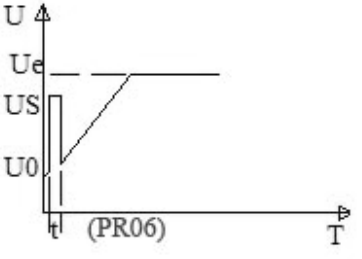
Set PR01 to 1 and set startup current limit percent Is（PR09）and Torque compensation voltage (PR04). The current of the motor will increase until the voltage ramp reaches Is, then it will stop, and the speed will accelerate to its full speed. After that, the current will decrease to below the rated current Ie, as shown in Figure (2):



Current Limit Startup Feature Curve (2)

△Kick startup

Set PR01 to 2, and set ramp start time t(PR07) and torque compensation (PR04), kick time t（PR06）. The motor will start rapidly along with the increasing voltage, then the voltage will increase in a ramp way, and the speed will accelerate to its full speed. It is better for startup motor with big inertia, as shown in Figure (3):



Kick Startup Feature Curve (3)

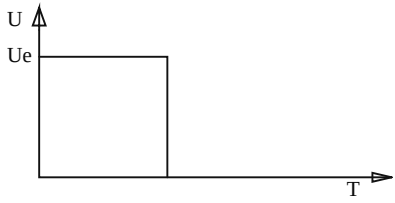
PR02	Startup delay time	0-600S	0S

Startup delay time is set for startup preparation, and the motor will not start in this interval. Count down mode is used for display, and the time can be set from 0 to 600 seconds. And it will output a normal open –normal close contact dot signal. By applying the signal, a warning signal may be affected for safety attention! The manufacturer value is set to 0S

PR03	Free stop	0 Free stop 1 Soft stop	0

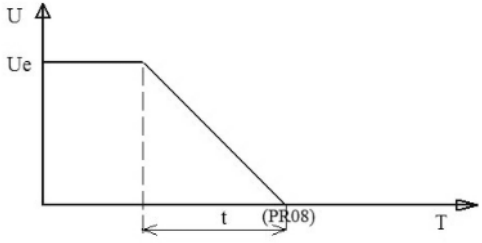
You can stop by selecting two modes: 0 free stop 1 soft stop. The manufacturer value is set to 0.

Free stop means that the voltage of softstarter will reduce directly from Ue to 0V， and the motor will run with inertia till its stop, as shown in Figure (4):



Free Stop Feature Curve Figure (4)

Soft stop means that the voltage of starter will reduce gradually from Ue to 0V when the voltage drops. The soft stop can help resist “water hammer domino effect”, as shown in Figure (5):



Soft Stop Feature Curve Figure (5)

PR04	Torque compensation	0-50% rated voltage	5%

Torque compensation means to adjust the torque produced by initial voltage U0. The manufacturer value is set to 5%.

PR05	Kick voltage	20-100% rated voltage	50%

As for a load with big static torque, an instant high voltage must be inflicted, so that it can start smoothly with the torque big enough, the "kick voltage" range is from 20% to 100% percent of the rated voltage. The manufacturer value is set to 50% rated voltage.

PR06	Kick time	1-60S	2S

Kick time means the interval to exert high voltage, adjustable between 1-60S. The manufacturer value is set to 2S.

PR07	Ramp ascending time	1-180S	20S

Ramp ascending time means the interval to bring the voltage from 0V up to rated voltage Ue. The manufacturer value is set to 20S.

PR08	Ramp descending time	1-180S	20S

Ramp descending time means the interval to bring the voltage from rated voltage Ue to 0V. The manufacturer value is set to 20S.

PR09	Startup current limit	150-400% rated current	400%

It works when PR01 is set to 1, startup current limit = PR09*Ie, please adjust PR09 for a successful start, less current is preferred.

PR10	Startup interval	1-3600S	240S

This equipment is small-sized, and you can only restart it when the radiator cools down from the previous startup, otherwise the machine will stop due to over-heating protection. The startup interval is adjustable, and no more than 10 startups per hour are preferred for full load startups. The manufacturer value is set to 240S.

PR11	Data initialization	0 no action 1 action (manufacturer value is restored)	0

When the data is in disorder, please restore the manufacturer value by setting data initialization 1.

PR12	Fault memory 1	Present fault	

Store and display the code for present fault, for example, 0 means no fault, 1 means OH overheating fault, 2 means OC over current fault, 3 means PF phase loss, 4 means OL over load or jam fault.

PR13	Fault memory 2	Last fault	

Store and display code of last fault, for example, 0 means no fault, 1 means OH overheating fault，2 means OC over current fault, 3 means PF phase loss, 4 means OL over load or jam fault.

PR14	Fault memory 3	Previous two faults	

Store and display the code of fault before last，for example, 0 means no fault, 1 means OH overheating fault, 2 means OC over current fault，3 means PF phase loss, 4 means OL over load or jam fault.

PR15	Fault memory elimination	0 no action 1 action	0

Available, when the PR15 setting is 1, all present fault codes, code of last fault and the code of previous two faults will be eliminated, and the display will be 0. When PR15 setting is 0, the program will be renewed automatically after each fault occurs. The manufacturer value is 0.

PR16	Overload protection time	1-180S	60S

When the continuous overload time has exceeded the setting time, protection program will work. At the same time it displays 0L. This will protect the motor from long time jam and overload running. The manufacturer value is set to 60S.

PR17	OL protecting value	100-400% rated current	300

Set the current threshold of overload protecting. The manufacturer value is set to 300% of rated current.

PR18	Stop bits	0: one 1: two	0

Set numbers of stop bits. The manufacturer value is one.

Note: User must choose one stop bit when parity check it enable; when parity check is null, user must choose two stop bits.

PR19	Parity check	0: Odd check 1: Even check 2: No check	0

Set the mode of Parity check. The manufacturer value is set to Odd check.

PR20	Communication baud rate	0 1200 bit 1 2400 bit 2 4800 bit 3 9600 bit 4 19200 bit	2

Set the communication baud rate. The manufacturer value is 4800.

PR21	Communication Address	1-127: softstarter address	1

Set softstarter address. The manufacturer value is 1.

PR22	Selection of ASCII mode and RTU mode	0 ASCII mode 1 RTU mode	0

Set communication mode of Modbus. The manufacturer value is ASCII mode.

PR23	Motor power	1-315KW	22KW

Motor power setting is applied for current display warp revising. The manufacturer value is set to 22KW.

PR24	reserved	0-9999	0

9. State Indication

9.1 Fault Indication

Over current protection ： OC (OC1 or OC2 will display because of different malfunctions)
Phase loss protection: P.F.
Overheating protection：OH
Over load protection：OL

9.2 Process State Display

Stop state ： STOP
Delay state ： Time count down
Startup state：RUN
Running state：OUT
Soft stop state：RT

9.3 Current Display

During the debugging process, press the mode key. The LED display value of current can be amended by adjusting PR17 function. Observe whether the max amount of current conforms to the setting amount, so that we can see whether the data setting is correct or not. When the startup is finished, and it works with full voltage, it can be examined by external current mutual inductor, with ammeter display.

9.4 Indicator Display

Indicator state	Softstarter state	Explanation
RUN○ FWD● DGT● FRQ●	Running state	Light is on in-running state after startup finished, and light is off in standby state.
RUN● FWD○ DGT● FRQ●	Delay state	Light is on when delay begins ，and light is off when delay ended.
RUN● FWD● DGT○ FRQ●	External control state	Light is on when external control works, and light is off in keypad state.
RUN● FWD● DGT● FRQ○	Current display	Light is on, and current is displayed when press MODE key during the startup process; light goes off when press it again, and state is displayed.

"○" indicates the light is on, "●" indicates the light is off.

Appendix 1. Maintenance

☞ **Be sure the power of softstarter is turned off, before you start any maintenance and checkup**!

- Please check the cooling channel of softstarter regularly, make sure it isn't blocked by trash and dust.
- Keep and install softstarter in a place far from strong eroding, high powder, high temperature or high humidity. Softstarter should avoid strong vibration.
- Clean it regularly and check whether it works properly.
- Check input wire and output wire of softstarter regularly. Check whether the grounded wire is reliable, and whether terminals become flexible.
- Renew startup contact implement (relay) regularly.
- Check whether there is imprint or parts damage caused by overheating.
- Check whether the wire is aging.

Note: When softstarter breaks down or doesn't work properly, please handle it according to this manual; Contact the manufacturer when you fail to solve the problems. Users are not allowed for any repair by themselves.

Appendix 2. Fault Diagnosis

Problems	State explanation	Troubleshooting
Motor sounds buzz, when power is on	Softstarter is in standby state	1. Check whether the bypass contactor is blocked at the closed place; 2. Check whether the silicon controlled rectifier (SCR) is spark-through or damaged.
Motor can not work normally with the startup signal input.		1.In external control state, check whether the terminal RUN-CM is turned on; 2. Check whether the control circuit connection is right, control switch works normally.
	No control power supply state	1. Check whether work voltage is normal.
	Wrong parameter set	1.Check every parameter set value one by one, make sure that the set values match the practical parameters of motor; 2.Check the current limit value
	Phase loss occurs during startup	Check three phases' voltage, judge whether there is phase loss and eliminate fault
	Wire connection of motor is open	1.Check whether the connection of output terminals of softstarter and what of motor is right and reliable; 2.Check the input terminals' voltage, judge whether internal circuit of motor is open; 3.Check whether there is phase loss in input terminal
Startup current exceeds the set value	Current limit function fails	1.Check whether the startup current set is right; 2.Check whether the connection of current mutual inductor is right; 3.Check whether the current mutual inductor works properly, and matches the motor.
	Environment temperature is too high	1.Check whether softstarter installation environment has good ventilation and is installed vertically; 2.Check whether softstarter avoids direct sunlight successfully;
	Over run current of	1.Check whether the softstarter has short circuit in output connection ;

	motor	2.Check whether overload of motor or damage happens; 3.Check whether phase loss fault happens in the motor.
	Softstarter is short circuit between input and output terminal connection	1.Check whether the bypass contactor is blocked at the closed place; 2.Check whether the silicon controlled rectifier (SCR) is sparked through or damaged

☞ The above problems must be handled by professionals. Users are not allowed for any repair by themselves.

Appendix 3. Application environment

Applied Machinery	Load type	Starting torque / rated load torque	Conduplicate inertial torque / motor's inertial torque	Starting current %
Centrifugal Pump	Pump Mαn^2	40%	1	300
Centrifugal Fan	Fan Mαn^2	40%	15	350
Centrifugal Compressor	Fan or Heavy Load ＞30S Mαn^2	50%	15	350
centrifugal Filter	Fan Mαn^2	20%	30	300
Piston-type compressor	presser Mαn	50%	1	350
Spiral-type compressor	presser Mαn	10%	1	300
Piston Pump	Pump M= constant		0.2～0.8	350
Fan	Fan or Heavy Load ＞30S Mαn Mαn2	40%	10	300
Cooling Compressor	Fan M=n			300
Belt Convey	M= constant	100%	10	300
Elevator	Grinding machine M=constant	100%	10	350

T-type Cable Car	Belt conveyor M= constant	100%	10	400
Spiral-type Conveyor	Belt Conveyor Mαn	100%	5	300
Circular saw Band saw	Belt conveyor or heavy load ＞30S M=constant			300
Mixer	Grinding Machine Mα1/n	120%	10	350
Draw bench	press Mαn	20%	10	350
Muller	Grinding machine or heavy load Mα1/n	100%	10	400
Hot Pump	pump Mαn	40%	0.5	350
Cutter	Grinding machine or heavy load M=constant	100%	10	400
Rolling Machine	Presser or heavy load Mαn	120%	15	450
refiner	Standard Load	100%	10	300
Pressure Machine	Presser or heavy load	120%	15	400
Lathe	Mα1/n	100%	3	350

Note: cubage type of fan is Mαn，the others are $M\alpha n^2$

User can set the parameter according to actual load.

To a little heavy load and heavy load, the manufacturer recommend user to choose higher power of softstarter. Furthermore, the startup mode of "Kick startup" is recommended for heavy load and heavy inertia.

Communication Manual for ETD

(Modbus Version 1.5)

I. General

Modbus is a serial and asynchronous communication protocol. Modbus protocol is a general language applied to PLC and other controlling units. This protocol has defined an information structure which can be identified and used by a controlling unit regardless of whatever network they are transmitted.

Modbus protocol does not need a special interface and a typical physical interface is RS485.

You can read reference books or ask for the details of MODBUS from us.

II. Modbus Protocol

1. Overall Description

(1) Transmission mode

1) ASCII Mode

When controllers are setup to communicate on a Modbus network using ASCII mode, each 1 Byte in a message is sent as two ASCII characters.

For example, 31H (hexadecimal data) include two ASCII characters'3(33H)','1(31H)'.

Characters	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'
ASCII Code	30H	31H	32H	33H	34H	35H	36H	37H
Characters	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
ASCII Code	38H	39H	41H	42H	43H	44H	45H	46H

The format for each byte in ASCII mode is:

Coding System: Hexadecimal, ASCII characters 0–9, A–F

One hexadecimal character contained in each

ASCII character of the message

Bits per Byte: 1 start bit

7 data bits, least significant bit sent first

1 bit for even/odd parity; no bit if no parity
1 stops bit if parity is used; 2 bits if no parity
Error Check Field: Longitudinal Redundancy Check (LRC)

2) RTU Mode

When controllers are setup to communicate on a Modbus network using RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that it's greater character density allows better data throughput than ASCII for the same baud rate.

The format for each byte in RTU mode is:
Coding System: 8–bit binary, hexadecimal 0–9, A–F
Two hexadecimal characters contained in each
8–bit field of the message
Bits per Byte: 1 start bit
8 data bits, least significant bit sent first
1 bit for even/odd parity; no bit if no parity
1 stops bit if parity is used; 2 bits if no parity
Error Check Field: Cyclical Redundancy Check (CRC)

(2) Baud Rate

Setting range: 1200, 2400, 4800, 9600, 19200

(3) Error Check

1) ASCII

Longitudinal Redundancy Check (LRC): The LRC is calculated by adding together successive 8–bit bytes of the message, discarding any carries, and then two's complementing the result. It is performed
on the ASCII message field contents excluding the 'colon' character that begins the message, and excluding the CRLF pair at the end of the message.

A procedure for generating an LRC is:

1. Add all bytes in the message, excluding the starting 'colon' and ending CRLF. Add them into an 8–bit field, so that carries will be discarded.
2. Subtract the final field value from FF hex (all 1's), to produce the ones–complement.
3. Add 1 to produce the twos–complement.

2) RTU

Cyclical Redundancy Check (CRC): The CRC field is two bytes, containing a 16–bit binary value.

The CRC is started by first preloading a 16–bit register to all 1's. Then a process begins of applying successive 8–bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

A procedure for generating a CRC is:

1. Load a 16–bit register with FFFF hex (all 1's). Call this the CRC register.
2. Exclusive OR the first 8–bit byte of the message with the low–order byte of the 16–bit CRC register, putting the result in the CRC register.
3. Shift the CRC register one bit to the right (toward the LSB), zero–filling the MSB. Extract and examine the LSB.
4. (If the LSB was 0): Repeat Step 3 (another shift).
(If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
5. Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8–bit byte will have been processed.

When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.

2 Functions and Format

(1) Modbus Message Framing

1) ASCII Framing

START	ADDRESS	FUNCTION	DATA	LRC CHECK	END
1 CHAR	2 CHARS	2 CHARS	*n* CHARS	2 CHARS	2 CHARS CRLF

2) RTU Framing

START	ADDRESS	FUNCTION	DATA	LRC CHECK	END
T1-T2-T3-T4	8 BITS	8 BITS	*n* x 8 BITS	16 BITS	T1-T2-T3-T4

(2) Function Codes

The table below shows the function codes supported by ETD soft starters.

code	name	description
03	Read Holding Registers	Read the binary contents of holding registers in the slave. Broadcast is not supported. (Less than 10 registers one time)
06	Preset Single Register	Preset a value into a single holding register

(3) Protocol Converter

It is easy to turn a RTU command into an ASCII command following the lists:

1) Replace the CRC with the LRC.

2) Change each byte in RTU command into a corresponding two bytes in ASCII.

3) Add a 'colon' (:) character (ASCII 3A hex) at the beginning of the message, and end with a 'carriage return – line feed' (CR LF) pair (ASCII 0D and 0A hex).

So we will introduce RTU Mode in the following part. If you use ASCII mode, you can

use the above lists to convert.

3 Address and meaning of command

(1) Description of rules of function codes and parameters address

1) use the function code as parameter address

High-order byte: F0

Low-order byte: 00~3C

Please put the function code low byte into hex format.

For example: PR14 (display on the board), parameter Address is F00E

Note: in this situation, only one function code is allowed operation of read/write one time.

Some functions parameters are read only, they can not be changed; and the other functions parameters are neither read nor changed; some functions parameters can not be changed when the soft starter is running, some functions parameters can not be changed whatever state the soft starter is in. The range, unit and related introduce of parameters are important when you change the functions parameters.

2) Definition address

Parameters and addresses are hexadecimal representation.

【1】 Running status parameters

Parameters address	Parameter Description （read only）
1001	Soft starter status: High-order byte is 0, low-order byte is soft starter status. 0000:stop 0001：run 0002：OC1 0003：OC2 0004：PF 0005：OH 0006：OL
1002	Output current

【2】Control commands

Parameters address	Parameter Description （write only）
2000	0003：decelerate stop 0004：free stop 0008：run（No direction ） 0009：reset

【3】Communication parameters

Parameters address	Parameter Description （read only）
3000	0000：no malfunction 0001：illegal function 0002：illegal address 0003：illegal parameters 0004：LRC error 0005：CRC error 0006：system locked

【4】Response

Command Description	Parameter Description
"Read" parameter responses	1、return code value in normal response 2、not allowed to read, FFFF(hex) is returned.
"Write" parameter responses	0001：operate successfully 0002：less than min value 0003：greater than max value 0004：not allowed to change 0005：in fault status 0006：system locked

Eg 1. Preset Single Register (function code as parameter address)

Change acc time（PR07） to 10s in slave soft starter 1

Query

Slave Address	Function	Register Address Hi	Register Address Lo	Preset Data Hi	Preset Data Lo	CRC Lo	CRC Hi
01	06	F0	07	00	0A	8B	0C

Function code PR07 value:10

Response

Slave Address	Function	Register Address Hi	Register Address Lo	response Data Hi	response Data Lo	CRC Lo	CRC Hi
01	06	F0	07	00	04	0A	C8

Function code PR07 Not allowed to change

Eg2, Preset Single Register (definition address)

Run slave soft starter 1

Query

Slave Address	Function	Register Address Hi	Register Address Lo	Preset Data Hi	Preset Data Lo	CRC Lo	CRC Hi
01	06	20	00	00	01	43	CA

Forward run

Response

Slave Address	Function	Register Address Hi	Register Address Lo	response Data Hi	response Data Lo	CRC Lo	CRC Hi
01	06	20	00	00	01	43	CA

Operate successfully

Eg3, Read Holding Registers (function code as parameter address)

Read the value of F017 in slave soft starter 2

Query

Slave Address	Function	Starting Address Hi	Starting Address Lo	No. of Points Hi	No. of Points Lo	CRC Lo	CRC Hi
02	03	F0	11	00	01	E7	3C

Response

Slave Address	Function	Starting Address Hi	Starting Address Lo	Data Hi	Data Lo	CRC Lo	CRC Hi
02	03	F0	11	00	04	27	3F

Eg4, Read Holding Registers (Definition address)

Read the status and current of slave soft starter 2

Query

Slave Address	Function	Starting Address Hi	Starting Address Lo	No. of Points Hi	No. of Points Lo	CRC Lo	CRC Hi
02	03	10	00	00	02	C0	F8

Response

Slave Address	Function	Byte Count	Data Hi	Data Lo	Data Hi	Data Lo	CRC Lo	CRC Hi
02	03	04	00	02	00	00	68	F3

3. **Additional Remarks**

(1) Expressions during communication course:

Parameter Values of Current＝actual value X 10

Others parameter Values＝actual value X 1

Parameter value is the value sent in the data package. Actual value is the actual value of inverter. After PC/PLC receives the parameter value, it will divide the corresponding coefficient to get the actual value. NOTE: Take no account of radix point of the data in the data package when PC/PLC transmits command to inverter.. The valid value ranges from 0 to 65535.

□ **Function codes related to communication**

Function Code	Name	Setting Rang	Mfr's Value
PR18	Stop bit	0 one bit 1 two bits	0

PR19	Parity Check	0:Odd 1:Even 2:No checkout	0
PR20	Baud Rate	0 1200 1 2400 2 4800 3 9600 4 19200	2
PR21	Soft starter's Address	1-127: Address	1
PR22	Modbus Selection	0 ASCII Mode 1 RTU Mode	0

You can read running status, value of function code and preset functions value of soft starter regardless of value of PR00.

Please make sure functions code related to communication consonant with the PLC/PC communication parameters, when soft starter communicates with PLC/PC.

Physical interface

1 interface

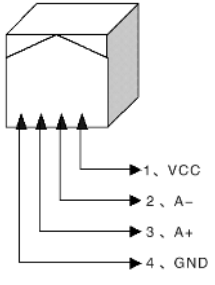
Hardware uses communication MAX485, the following are the pins of 485 interface.

VCC: 5V power supply

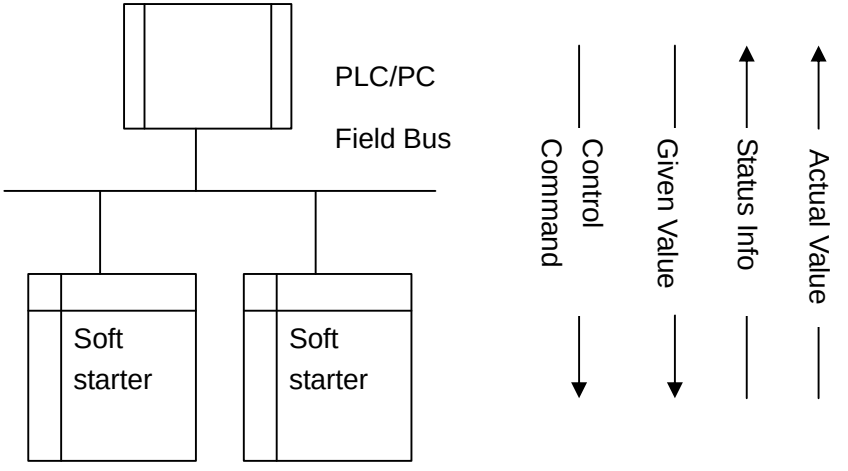
GND: ground of 5V

Connect A+ to A+ of PLC or other converter, connect A -to B- of PLC or other

Converter, when soft starter communicates to other devices.



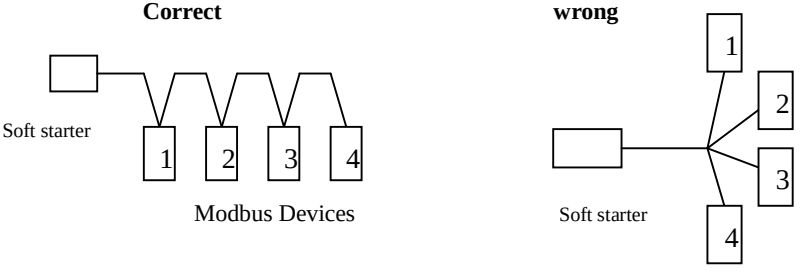
2 Structure of Field Bus



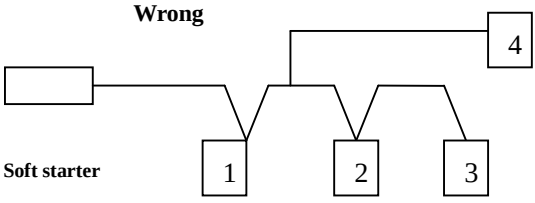
Connecting Diagram of Field Bus

RS485 Half-duplex communication mode is adopted for ETD soft starter.

Daisy chain the devices together. Do not use 'spur' lines or a star configuration, because they will produce reflecting signals to interfere communication 485. Terminating Resistors of 120 Ohms should be used at the ends of Modbus/485 loops. In the first example below, the terminator should be placed at the PLC and Modbus device 4.



Modbus Devices



Modbus Devices

Please note that at the same time in half-duplex connection, only one inverter can communicate with PC/PLC. If two or more than two inverters upload data at the same time, bus competition will occur, which will not only lead to communication failure, but higher current to certain elements as well.

No direct grounding shall be allowed for any points of RS485 network. All the equipment in the network shall be well grounded via their own grounding terminal. Please note that grounding wires will not form closed loop in any case.

Please think over the drive capacity of PC/PLC and the distance between PC/PLC and inverter when wiring. Add a repeater if drive capacity is not enough. Modbus repeaters may be used to extend the length of the loop, but the response time will be delayed. Using repeaters on slow devices may cause timeout problems.

All wiring connections for installation shall be made when the soft starter is disconnected from power supply.

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